Teacher Education

★ March 1941

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TEACHER EDUCATION

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The Education of the High School Physical Science Teacher

HOWARD W. ADAMS*

BEGINNING with World War I and continuing through the depression period to the present, the United States has witnessed the rise of a new and far-reaching business, the chemical industry. Prior to this, industrial development was concerned chiefly with extension of means of communication, winning of metals from their ores, building of machinery, and bringing great areas under cultivation. This new industry concerns itself with profound transformations, such as the changes of limestone, sand, and clay into glass, cement, and aluminum, or the production of textile materials, fertilizers, and explosives from coal, salt, air, and water. Petroleum has become the starting material for the production of numerous compounds never before known. Agricultural products are transformed into textiles, plastics, and fuels. The versatility of this youthful industry is attested by the fact that it suffered less from the depression than any other business. This new industry embraces twenty per cent of the nation's manufacturing.

The chemical industry is the creation of scientific research. The research worker, thus, is a dominant figure. Never before has business been so intimately associated with science, particularly the physical sciences. Research has made itself felt in the money markets, in production, in marketing, and in the creation and satisfaction of human wants.

What account shall public education, particularly secondary education, take of this transition in American industrial life? Shall educators continue to place educational emphasis upon the individual and his cultural development, or shall a new outlook lead educators to place more emphasis on that education which will prepare the individual and the nation to live in the changing times which are approaching?

If the United States is to maintain her position of leadership in world affairs, she must be able to adapt her industrial life to present-day demands. She must create and hold new markets. She must be prepared to defend herself against aggressors. In both of these aspects, scientific prowess is necessary.

In the new scientific industrial order, both scientific leaders and intelligent workers are necessary. The training of the latter group is particularly the function of the public schools. No division of labor or use of automatic machinery can, in the new industrial order, take the place of an intelligent, resourceful worker. In this order, it is not so much dexterity as the fundamental knowledge of mathematics, physics, and chemistry that counts.

An examination of the American public high school reveals that the

* Head of the Department of Physical Science and Professor of Chemistry.

physical sciences are on the decline, and at a time when the nation as never before needs workers trained in this field. The secondary school furnishes the terminal education of the great portion of American youth. Formerly the high school graduate could look forward to a white collar job, but today the greater part must expect to be wage earners using a combination of hand and headwork. Young men must earn their way in manufacturing or in agricultural industry, in which their earning power will bear direct relationship to their intelligence. Young women, finding themselves eventually in their own homes, are the better home makers for a knowledge of the sciences. Here, production is not the main issue, but rather intelligent consumption.

American high schools need effective teachers of the physical sciences. The preparation of these teachers is one of the functions of the Department of Physical Science at the Illinois State Normal University. Upon entering the high school, the prospective teacher of the physical sciences should begin a college preparatory course, including beside the study of English and the social sciences, one year each of German and French, and a year and a half each of algebra and geometry. The science program for prospective teachers should include general and biological sciences, chemistry, and physics, one year each. The social life of the student should receive emphasis, but the work of the classroom and the laying of the academic foundation should receive first consideration.

Upon entering the teachers college, the student should continue the work in mathematics through calculus. The biological sciences should be elected as far as time will permit. French and German, as well as English, the social sciences, and professional courses in education should be included. The academic work in the physical sciences should be continued in college, including a survey course, together with courses in mechanics, heat, light, sound, electricity, and the modern concepts of atomic constitution and energy. His chemical training, likewise, should include work in general inorganic, qualitative and quantitative analysis, organic chemistry, and, if time permits, physical chemistry. In this academic work, the student is laying the intellectual foundation for both his graduate work and his teaching career.

Practice teaching in general science, high school physics, or high school chemistry under the supervision of an expert high school teacher is included. Preceding or accompanying the student teaching are methods courses dealing with the particular problems of physical science instruction. In the practice teaching in the high school, a functioning science that contributes to efficient living as well as toward making a livelihood is always emphasized.

The physical sciences in the secondary school should not be too highly departmentalized. Such departmentalization may seem to lead to more efficient instruction but is less fruitful for the individual. In his life work problems, there will be no departmentalization into this branch of knowledge or that, but the problems will come to the individual as difficulties to be solved.

Finally, school administrators should be aware that a working mastery of these sciences requires more time than has formerly been given in high school. No other bodies of knowledge have increased with such rapidity as the sciences of physics and chemistry. The last fifty year advance is probably greater than all the knowledge of the physical sciences gathered by the race up to that time. These new times with new demands require more time for preparation than the traditional one year of high school chemistry and one year of physics. If other courses cannot give place to these increased demands, the high school training period should be lengthened. Surely the demands of industry for new workers are not so urgent that these youths could not spend an additional year in needed training.

Because the members of the department of physical science in this Teachers College are fully aware of the place of these sciences in national life, it is their purpose to train prospective high school teachers so that these teachers may pass on their training to the youth of the nation.

Visual Education for Science Teachers

C. L. Cross*

The education of a modern science teacher involves many factors,—so many, that in the short space of a four year college course, some desirable goals cannot be given proper consideration. It is also true, that with the rapid rate of scientific development, no science instructor entrusted with the responsibility of educating future teachers, has the foresight to predict, much less to train others for what may be needed a quarter of a century later. A good example of this fact is the projection and public address equipment which is now found in many of the school systems of Illinois. Twenty-five years ago this equipment was not used in schools. The physics teacher who completed his preparatory training at that time had no opportunity to learn the use of such equipment in college. This fact does not, however, relieve him of the responsibility of training those he now teaches.

Yet the defense is heard: "There is so much to teach and so little time to teach it. There is such rapidity of change that we can have little hope of supplying our students with the exact material which they will need when they become teachers, a few years later." In answer to this statement, it is axiomatic that a science teacher must have certain basic knowledge. Nothing can take the place of such knowledge. Too often, however, this is set as the one and only goal. The science teacher is inclined to call his work well done when he has achieved it. The work of the science teacher requires

* Associate Professor of Physics.

more than the ability to teach science as science was taught to him. He must have, in addition, a willingness to serve and a desire to grow.

Though there are many areas, such as radio, civil aviation, public address systems, and national defense that could be discussed to show the extent of the science teacher's opportunities and responsibilities, this article will be confined to Visual Education.

Within the present century, much has been done toward perfecting visual equipment and techniques. Science has given us much more effective tools than abstract words. Business is aware of this fact. Every advertiser devotes most of his expensive space to pictures. Modern methods of picture reproduction give an art, a realism, and a condensed way to express ideas that no other generation has had. An old Chinese proverb states, "A picture is worth a thousand words." If this was true at the time this proverb originated, how much more true it should be today with modern picture reproduction.

People do not always realize the importance of pictures in their lives. They depend largely upon pictures to tell them what to buy. They use pictures to give accurate impressions of what is happening in the world. The magazine that has had the most phenomenal growth within recent years is *Life*—a magazine which depends on pictures to tell its stories. No form of entertainment has ever attained the present universal popularity of the motion picture. Can teachers afford to neglect such a powerful tool?

I shall take time to point out some of the contributions of science to pictures. Of course, the picture is a scientific creation. However, I wish to call attention particularly to the part science has played in the understanding and enjoyment of pictures.

First, and that which contributes most of realism in pictures, is third dimension. By means of the stereoscope, a scientifically designed instrument, one is led to perceive depth in a flat picture. The stereoscope, developed nearly one hundred years ago, was designed in its present form by Oliver Wendell Holmes. Thirty years ago, these instruments and the accompanying stereographs were frequently found on the parlor table. Their chief function here was to serve as a means of diversion and entertainment for the waiting guest. Today, with better pictures and improved lenses, the stereoscope and the stereograph have a place in the school room. Teachers have been slow to recognize the ability of this instrument to give correct ideas. It gives an accurateness of detail exceeded only by the object itself.

This instrument has another value, —it is useful as a medical instrument. Many eye defects have been detected by the use of the stereoscope. An individual will not see third dimension, when the stereoscope is used, unless both eyes function.

Projection equipment may be considered next. With the development of electricity and its usage in the modern electric lamp, came the possibility of good projection equipment. The development of desirable photographic technique enabled the projection of pictures on a large screen to become a

reality. Screens have been perfected so that now it is possible for many people, even thousands at a time, to look at the same picture. In addition to photographic reproductions, it is possible to project many other types of material by means of the slide lantern. Material may be typed directly on a flexible transparent substance, such as cellophane, and projected so that all may see. With transparent colored crayons and colored inks, drawings in color may be thrown on the screen. Color photography, as found in the Kodachrome film, is one of the later additions to the projection of color on the screen.

Many types of projectors have been developed. No one projector serves all purposes. The question of expensive projection material has been met by what is known as the opaque projector. This instrument, as the name indicates, projects images of opaque material on the screen. Pictures, charts, and graphs of all types from books and magazines can be shown on the screen. Thus, a single picture can be made available to a large group at the same time. The picture appears on the screen in its original color. Small objects and specimens may also be shown to a large group with the aid of the opaque projector. There is little expense involved in securing material for use in this projector. Material can be found everywhere. Other than paying the electric bill and replacing an occasional burned out lamp, there need be no expense involved.

The opaque projector has some defects, however. The machine is large and cumbersome. It is hard to get enough light reflected from opaque material to form a bright image on the screen. This condition requires that the machine must be used in a well darkened room and that a good reflecting screen must be available. Likewise, it calls for the use of high wattage projection lamps. These lamps develop much heat, which may be detrimental to valuable pictures and specimens.

Another projector of rather recent origin, which overcomes to some extent the expensiveness of the lantern slides and the lack of portability on the part of the opaque projector, is the film strip projector. As the name indicates, this machine uses pictures on strips of 35 mm. motion picture film. The recent development and the popularity of the miniature camera have given a great impetus to the use of this projector. Thus, it is well adapted to local usage. Many film strips, particularly on agricultural subjects, are now available from commercial concerns. The cost of these strips, which often contain fifty or more pictures, is from fifty cents to two dollars per strip. Thus, the cost ranges from one cent to five cents per picture. The film strips can be stored in a small space. A box the size of a rather thick book will hold twenty film strips—two thousand or more pictures. It is possible and sometimes desirable to cut film strip and mount the individual pictures as two by two inch slides. This method is a cheap way to secure colored slides which are usually quite expensive if purchased as standard lantern slides. Kodachrome film, when properly exposed and developed, gives excellent colored slides. The film strip projector is small and gives excellent colored

slides. Since the film strip projector is small and light weight, it makes a useful machine in a school system.

The projector of which science can be truly proud and which has exerted the most influence on the lives of the present generation is the motion picture projector. One can imagine what the sensations of a person whose experiences were limited to those of Washington or Lincoln would be if he were to visit a modern motion picture theatre. To such a person, the days of miracles would not be past. Most people today accept the motion and the sound of the picture because they have grown up with it and accept it as a matter of course. After all, it is a wonderful scientific achievement.

I can discuss only a few of the unusual techniques which make the motion picture valuable. It may be well to start with time lapse photography. The modern sound projector flashes pictures on the screen at the rate of twenty-four per second. Suppose that individual pictures involving the growth and development of a plant are taken at ten minute intervals. These pictures are then flashed on the screen at the rate of twenty-four each second. The onlooker sees then in one second, the growth the plant made in 240 minutes, or four hours. One minute shows 240 hours or ten days of growth. Hence, one reel or ten minutes of pictures can show one hundred days or the complete life cycle of the plant. Dr. Glenn Frank, the late president of the University of Wisconsin, after seeing a film of this type, commented as follows: "Yesterday, within the space of ten minutes, I saw a plant grow to full maturity, bear fruit, and die. I had to wait forty years to see it, but yesterday, the thing I wondered about as a child happened."

There is also the converse of time lapse photography, the slow-motion picture. Here, the pictures may be taken more rapidly than they are run off by the projector. If 240 are taken per second, and then projected at the rate of twenty-four per second, it will take ten seconds to see an action that happened in one second. Action too quick for the eye to follow can thus be shown in great detail.

Animation is another outstanding contribution of science through the film to education. Hidden processes and ultra-microscopic actions may be pictured by means of drawings. These drawings take on life when flashed by the motion picture projector on the screen. Ideas can be given by this method with a vividness and a dramatic effect that can be attained in no other way.

These are a few of the contributions of science to education by means of visual aids. Since projection equipment has been developed and operates in accordance with physical science principles, the physical science teacher is the logical person to assume the responsibility for the operation and care of this equipment.

Many schools in Illinois now have projection equipment. Within the past ten years, Illinois has made much progress in the establishment of film libraries. The University of Illinois started a cooperative film library in 1933. This library now has more than eight hundred different film titles, all

on 16 mm. film. Almost half of these are sound films. Lewis V. Peterson, who has charge of this library, estimates that the pupil audience for this library this year will be more than two million.

At least four of the five Teachers Colleges in Illinois have made a start on film libraries. Carbondale is the only one of these that makes any attempt at present to serve schools other than those directly affiliated with the college. Some of the larger public school systems of the state also own their own film libraries.

These facts should be sufficient to show the trend. This development places an opportunity for service at the feet of the science teachers. Those college teachers who attempt to educate science teachers can render a service by including more instruction on visual aids. The future teachers must get this instruction while they are in training, or they will have to learn by trial and error after they begin to teach.

Consumer Science in the Secondary School

RALPH W. FOGLER*

UP TO THE time of the last World War, the high school had one main function to perform,—that of preparing its students for college. The high school met the challenge and performed its function well. Since the World War, the secondary school has a changed population. Instead of the majority's preparing to go to college, the majority are preparing to take up their life work at the end of the second, third, or fourth year of high school. The high school graduate of today is very likely to be a clerk in a chain store, a stenographer, a beauty operator, a mechanic, an elevator operator, a filling station attendant, a bell-hop, a truck driver, or a worker in one of the many other jobs that are necessary to carry on smoothly the business of the world.

It seems, then, that the high school has two functions to perform now, instead of one: that of preparing people for college, and that of helping prepare the student to adjust him or herself in the new field of endeavor. The high school, for the most part, has ignored the new challenge; particularly in the field of science, this condition has been true. Though many new books have been written and though such books have included many new pictures in an attempt to keep abreast of scientific progress, the content and approach are essentially no different from the traditional college preparatory course.

In the last nine or ten years, Consumer Science has appeared to meet the challenge of the new high school population. Though it has championed the cause of science for the many, it does not ignore the few who are pre-

* Assistant Professor of Chemistry.

paring to go to college. Its purpose is to teach the basic principles of science through familiar objects and occurrences of everyday life, so that the student will gain facility in applying these principles in his thinking about and in the solution of life problems. The practical aspects of science are not considered at the expense of the understanding of basic principles but are utilized functionally to apply those principles.

Consumer Science does not depend upon some distant industry for all of its practical application of scientific principles, but instead uses as its teaching material the commodities that come into the home every day in the year. Science is something near, something that touches everyday life and not something that is far removed or something that applies to industry alone.

Consumer Science can also help to stretch the small income of the average family to cover the things the members of the family need and want. The increased knowledge enables them to buy and use goods efficiently and economically. Since science plays such an important part in the production, the determination of quality. the distribution, and the marketing of goods, it assumes a new role in the everyday world in which the consumer lives. In the new role, science must work for producer, laborer, and consumer alike and serve each to the utmost of its potentialities.

Consumer Science offers unlimited opportunities to the teachers who believe in child-centered emphasis in education. Many science teachers think that the important outcomes of science study lie in the realm of scientific attitudes and in the understanding of the scientific methods, rather than in the accumulation of many scientific facts. Their concern is with the activities of the students, not those of the teacher. Consumer products furnish a fertile field for student activity.

The opportunity for teaching the student these important outcomes of science may arise from reading in a magazine or newspaper, or from listening to the advertiser over the radio when he states or implies that different brands of the same commodities vary in quality. What are the factors that determine quality? Here again science steps to the front since quality may be determined by scientific procedure in nearly all cases.

If the quality of two products is not the same, what is the cause? The determination of the factors involved in quality aids materially in impressing the cause and effect relationship that is so essential to intelligent thinking. It develops a scientific curiosity that brings out the quantitative and qualitative factors. For example, in determining quality of peas, one should consider five things. Uniformity of color and of size is assigned ten points, whereas tenderness and maturity are given thirty-five points. Thus, in judging the quality of various products, the student learns to be discriminating in picking out and assigning values to various factors. He is offered an opportunity to have experiences in judging quality of many products upon the basis of data collected by his scientific experimentation. After all, the

success of the experiment lies in leaving that search to the student.

Leaving the search to the student means a reduction in the number of topics or units for study during the year, because allowing pupils to engage in varied activities and to learn from their own experiences requires more time than participating in group activities as planned and directed by the teacher. The reduction helps to create an unhurried atmosphere in the classroom. Such an atmosphere aids careful observation, accurate expression, well-founded conclusions, thoughtful application and challenging optional projects, all of which are very essential for developing scientific attitudes, for understanding the scientific method, and in acquiring a functional knowledge of the fundamental principles of science.

Very few things are as fundamental to the welfare of a family as the way its income is spent. Is it not the function of the school to promote more intelligent awareness of correct buying? The school must assume the responsibility for future consumers as they will be those who spend the nation's wealth. If this spending is wisely done, the school must aid the pupil to develop an interest in securing greater satisfaction from the money spent, to develop an ability to evaluate and use available information concerning materials to be purchased, to develop the ability to analyze advertising propaganda, to develop the desire for legislation which will make it possible for the consumer to be a more intelligent buyer. The student should also come to know federal and state laws that protect the consumer and should become familiar with the many departments or divisions of the government that are working in the interest of the consumer and that have much valuable material to offer, either free or at a very low cost, to every family.

Units on foods, labels, seals of approval, advertising, detergents, fuels, various commodities for the household, textiles, and drugs are desirable and should be included in every consumer science course. For example, the inclusion of a unit on drugs is justified when the fact that the large sum of $715,000,000 is spent annually for medicines in the United States is considered. Since seventy per cent of this amount is for self-medication, it is doubly necessary that the pupil be instructed in the nature and use of drugs. Consumer Science can and should teach the student to acquire health ideals, to be able to purchase drugs economically and wisely, to know when to consult a physician, to learn the place of self-medication in the treatment of illness, to recognize health fallacies and erroneous health advice circulated through advertising media, to learn to read drug labels intelligently, to know the economic waste and health hazards involved in the use of worthless and harmful medicines, to know where one may obtain reliable information concerning drug products, and to know the provisions of the Federal Food and Drug Law as well as the extent to which it protects the consumer of drugs.

One might ask what has become of the college preparatory student in this type of science work. That it will aid

him, too, as a consumer, is clear, but will it meet his needs for college entrance requirements? If one thinks of college preparatory work in chemistry, for example, in terms only of the student's having prepared oxygen, and having burned carbon, sulfur, and phosphorus in the oxygen, or having prepared hydrogen and chlorine, or having studied the properties of culfur so that he can repeat these experiments again in the beginning college course, then he has not been prepared for college entrance. However, if one means basic scientific laws and principles, then the student has been prepared for college entrance. All science teachers should see the possibility of teaching scientific principles and at the same time putting into practice the following psychological laws of learning: (1) Learning is more efficiently accomplished when interest becomes inherent in the material to be learned. (2) All education is based upon the instinct of curiosity. (3) Increased interest increases efficiency of learning. (4) If inherent interest is the motive power, learning is more efficiently accomplished.

For example, in grading and testing peas, the science teacher understands that the percentage of liquid and solids in the can offers an opportunity to teach the relationship between English and metric systems through the weighing and measuring of solids and liquids in the can. Likewise, in determining the tenderness and maturity of peas, the student comes to know that various per cent solutions of sodium chloride, ranging from seven to seventeen per cent are used. The per cent solution in which the peas will float is the determining factor for scoring the peas for tenderness and maturity. This problem furnishes an opportunity to teach solutions as well as the way in which percentage solutions are made up. In addition, it furnishes an opportunity to teach Archimedes' principle. In the consideration of adulterants that may be found in peas, an opportunity arises to teach chemical formula writing as well as the fact that metals and radicals have specific tests of indentification. These are only a few of the principles that may be taught in connection with the grading of peas.

Other products afford equally interesting problems. The following scientific principles and facts present themselves naturally in the testing and evaluation of the anti-freezes on the local market: density, solubility, ionization, lowering of the freezing point (Ralont's Law), molecular weights, per cent solutions, boiling point elevation of solutions through the use of evaporation retarders, relationship between Fahrenheit and Centigrade thermometers, action on metals found in automobile cooling system, specific heat and viscosity. The student is also given the opportunity to make use of the hydrometer and the viscometer, to carry out fractional distillation, to plot graphs showing the relationship among the amounts of various alcohols needed to protect at various winter temperatures, and to plot graphs dealing with the relationships of specific gravity of the alcohol-water solutions needed to protect in winter temperatures. Furthermore, there is opportunity to pick

out the properties that are desirable in an anti-freeze, to list these in order of importance, and to assign a value to each. This is good scientific training, since the student weighs evidence not only quantitatively but qualitatively.

The problem of using detergents may now be considered. How is this problem related to science and everyday living? The use of Bloomington or Normal water has been a community problem for the last ten years; the use of Normal water has been a problem for the last eighty years. What science may be taught that has to do with the use of water softeners, soap, soap chips, beads, flakes, and soapless soaps that are found on the grocer's shelf? A quick analysis reveals that the following things may be taught: minerals that cause temporary and permanent hardness, the method of removing hardness, the determination of hardness by titration with standard soap solution, the reaction of soap with calcium in water, the chemistry of soap and fats, impurities found in soap as well as the reason for their being there, methods by which soap cleanses, determination of moisture and air in soap, titration of free alkali in soap, the chemical constituents of water softeners on the market, and the reasons for the need of soft water for both laundry and industrial purposes.

Another aspect of science teaching is found in the preparation of tooth powder. The students test the individual properties of each of the ingredients, noting and recording which ones will polish, which ones will neutralize acids, and which ones will taste and flavor. After blending all of the materials together to form the mixture, he again tests and notes the original properties which have been retained. In this manner he has learned the characteristics of a mixture as well as something about tooth powders.

These are only a few examples of some of the products that may be studied and the avenues they afford for teaching basic scientific principles. In the consumer market the fields are just as rich and just as green for teaching science as in the production side, which is so frequently stressed. Since the problems of the consumer are closely associated with the problems of the producer and the laborer, one cannot be dealt with alone, but they must be considered only in relationship with each other.

Consumer Science starts with the practical and teaches the principles and theories as they arise, whereas most of the traditional courses teach principles and theories and point out some practice that usually does not function for the individual. Consumer Science clearly sets up goals of achievement and contributes much to the ability of the student to direct himself. After all, is not wise self-direction on the part of the pupil one of the cherished outcomes of education? Consumer Science gives the student a better insight into science as a vocation since the type of work carried on in the laboratory and by the problem-solving approach more closely parallels the work of a commercial laboratory than does the traditional science course. Finally, consumer work is interesting; it is self-motivating. My experiences have shown that students enjoy it.

The Cost of Equipping a Small High School Chemistry Laboratory

R. U. GOODING*

IN THE early days of the depression, school boards and administrators, in attempting to reduce expenses, eliminated many courses from the high school curriculum, among them chemistry. With the present defense demand for more science training in the national defense program, it would appear that this curtailment was false economy.

Some schools are now desirous of re-establishing their former chemistry courses and other schools, where chemistry has never been taught, are considering the addition of it to the curriculum. Many of the administrators of these schools, fail to recommend this change to their boards because they feel the cost would be prohibitive. They seem to have a mistaken idea about the cost of equipping a laboratory and tne expense of its operation.

It is not necessary, when starting a course in chemistry, that one have all the equipment desirable for teaching the course. There are some minimum standards which must be met. To these materials additional equipment can be added as funds are available. It is also an erroneous idea that equipment be expensive to be good. Many times equipment made from ordinary inexpensive materials will serve the purpose as well or better than an expensive piece of apparatus obtained from a supply house. An example of this is the equipment used to illustrate Boyle's Law. If purchased from a supply house, the supplies would cost from five to thirty dollars, depending upon how elaborate an outfit one wishes to have. In contrast to this, one can make an apparatus which will serve the same purpose from inexpensive materials to be found in any laboratory.

Simple apparatus is best for teaching purposes. Many times the teacher is inclined to set up or purchase elaborate equipment which can not be understood by the student. Here a simple piece of apparatus would have been more effective in conveying to the student the principle that is to be taught.

Not only is the equipment comparatively inexpensive but the cost of chemicals is small. Many laboratory directions, especially those in older books, specify the use of too large amounts of materials. Just as there is today a trend toward semi-micro procedures in qualitative analysis, so can the quantities of materials used in many experiments in general chemistry be reduced. This reduction does not reduce the effectiveness of laboratory teaching and does result in a small saving in chemicals.

If the cost of equipping a chemistry laboratory is compared with the cost of equipping a physics laboratory, one

* Associate Professor of Chemistry.

finds the latter to be over twice that of the former. In referring to circular number 298, issued by the State Department of Public Instruction in Springfield in 1938, one notes that the cost of physics equipment designated as essential for a class of twelve students working individually or twenty-four working in pairs totals approximately $670. In contrast to this, the cost of chemical equipment and supplies for a like number of students totals $295.00. These amounts include many items which can be made by the class or teacher at a great saving. For example, a Kipp generator, listed at $9.00, an electrolysis apparatus at $7.65, and a Boyle's Law apparatus at $9.50, could be made for less than $5.00, a saving of over $20.00.

The lack of elaborate laboratory furniture need not be a handicap to the teaching of chemistry. Laboratory desks equipped with gas and running water are desirable but not necessary. One sink of ample size in the room is sufficient. Small pneumatic troughs can be used for collecting gases by water displacement and similar experiments. These sell for about eighty cents each but can be replaced by a less expensive rectangular pan of tin or enameled steel. Where gas is not available, alcohol lamps may be used for heating, or bottled gas can now be purchased at a very low cost.

In schools where general science, biology, or physics are taught, much of the equipment included in the following list will be available: burners, beakers, bottles, clamps, test tubes, balance weights, graduates, hydrometers, magnets, meter sticks, and thermometers. Many of the chemicals will also be found in stock. This will reduce the initial expense for supplies and equipment.

The breakage in a high school chemistry laboratory is not extensive and requires only a small annual outlay for replacements. In our beginning course in chemistry, the average laboratory bill was 47.9 cents per student. This amount included ten cents for a towel and nine cents for materials which were used and not broken. Thus, a balance of 28.9 cents was left for breakage.

The following list of equipment and chemicals is taken from circular 298 of the State Department of Public Instruction. The prices are those of January, 1941, and were furnished by the Central Scientific Company. This list should be altered in both nature of materials and quantities to fit the needs of each course.

SCIENCE EQUIPMENT FOR CHEMISTRY
REQUIRED INDIVIDUAL APPARATUS

For a class of twelve students, or twenty-four working in groups of two. Quantities should be increased or decreased for larger of smaller classes respectively.

12	**Alcohol Lamps,** with wick, ½ in. diam.	ea., $.60; per 12	$6.24
12	**Beakers,** "Pyrex," 100 cc	ea., .18	2.16
12	**Beakers,** "Pyrex," 250 cc	ea., .15	1.80
12	**Bottles,** Reagent, No. 2, Hydrochloric Acid	ea., .48; per 12	4.75
12	**Bottles,** Reagent, No. 4, Sulphuric Acid	ea., .48; per 12	4.75

12	**Bottles, Reagent, No. 5, Nitric Acid**	ea., .48; per 12	4.75
12	**Bottles, Reagent, No. 15, Ammonium Hydroxide**	ea., .48; per 12	4.75
36	**Bottles, w. m. 8 oz.**	per 12, .60	1.80
12	**Brushes, test tube, fan tip**	per 12	.50
12	**Clamps, burette**	ea., .30	3.60
12	**Clamps, test tube holder, Stoddard**	ea., .04	.48
16	**Crucibles, No. 00**	ea., .17	2.72
16	**Crucible Covers, for No. 00**	ea., .07	1.12
12	**Deflagrating Spoons, brass, ¾ in. cup**	ea., .07½	.90
16	**Dishes, evaporating, No. 00A**	ea., .20	3.20
12	**Files, triangular, 3 in.**	ea., .09; per 12	.96
12 bxs.	**Filter Paper, 11 cm box of 100**	per box, .13	1.56
18	**Flasks, Erlenmeyer, "Pyrex," 250 cc**	ea., .20	3.60
12	**Forceps, laboratory, 5 in.**	ea., .07	.84
12	**Funnels, glass, 65 mm diam.**	ea., .21	2.52
18	**Funnel Tubes, moulded thistle top**	ea., .10	1.80
24	**Glass Plates, plane, 100 mm**		*
12	**Rubber Stoppers, 2 hole, to fit 8 oz. w.m. bottle**		.30
12	**Rubber Stoppers, 2 hole, to fit 250 cc "Pyrex," Erlenmeyer flask**		.27
12	**Rubber Stoppers, 1 hole, to fit ¾ in. test tube**		.15
35 ft.	**Rubber Tubing, 3-16 in. (In multiples of 5 ft.)**	per ft., .08	2.80
12	**Stirring Rods, 6 by 3-16 in.**	per 12	.27
12	**Supports, ring stands, 3 ring**	ea., .95; per 10, 9.00	10.80
12	**Supports, test tube, 13 tube**	ea., .45; per 12	4.80
144	**Test Tubes, soft, 6x¾ in.**	per gross	2.70
18	**Test Tubes, "Pyrex," thick wall, for ignitions, 150x18 mm.**	ea., 12	2.16
12	**Triangles, pipe stemmed, 2 in. sides**	ea., .09; per 10, .70	.84
12	**Troughs, pneumatic, enameled steel, improved form**	ea., .75; per 12	7.62
12	**Watch Glasses, 2½ in. diam.**	per 12	.35
12	**Wire Gauze Squares, asbestos centers, 5 in.**	ea., .08½	1.02
	TOTAL		$88.88

REQUIRED GENERAL APPARATUS

4	**Balances, hand**	ea., 1.80	7.20
1	**Balance, open, on case, 100 g. by 5 mg.**		9.90
1	**Balance, Cenco Triple Beam Trip Scale, 1110 g. by 1-10 g.**		10.45
4 sets	**Balance Weights, brass, 1 ctg to 50 g, in block**	per set, 2.00	8.00
1	**Barometer, mercurial, 0 to 4000 ft**		20.90
1	**Boyle's Law Apparatus, flexible tube form, on support**		*
1 set	**Bottles, reagent, 12 in set**		4.75
6	**Burettes, plain tip, 50 cc**	ea., .60	3.60
6	**Burette Tips, with pinchcock and tubing**	ea., .12	.72
1 box	**Candles, paraffine, 12's, 12 in a box**		.22
1 pkg.	**Charcoal Sticks, 12 in pkg.**		.45
1	**Chart, Periodic Law, 62x42 in., 1938**		2.45
2	**Condenser, Liebig, Bakelite Nut Assembly, can be supported with burette clamp, 300 mm**	ea., .80	1.60
2 sq. ft.	**Copper Sheet, No. 30**	per sq. ft., .42	.84
1 bag	**Corks, XX, Nos. 0 to 11, 100**		.40
1 bag	**Corks, XX, Nos. 12 to 26, 100**		1.95
1 set	**Cork Borers, brass, 6 in set**		.60
1 pkg.	**Cotton, absorbent, 1 oz.**		.09
6	**Dishes, graniteware, 2 pt.**	ea., .12	.72
1	**Electrolysis Apparatus**		*
6 pkgs.	**Filter Paper, 11 cm diam.**	per pkg., .13	.78
1 qr.	**Filter Paper, 20x20 in.**		.40
1	**Flask, volumetric, 1000 cc.**	ea., 1.00	1.00
1	**Gas Generator, Kipp's, 500 cc**		*

1 lb.	**Glass Rods,** 3 mm	.65
2 lbs.	**Glass Tubing,** soft, 6 mm. per lb., .50	1.00
6	**Graduates,** cylindrical, 25 cc ea., .30	1.80
6	**Graduates,** cylindrical, 100 cc ea., .50	3.00
1	**Graduate,** cylindrical, 500 cc	1.00
1	**Hydrometer,** for heavy liquids	.45
1	**Hydrometer,** for light liquids	.45
2 bxs.	**Labels,** gummed, No. 201 per 12 boxes, .90	.15
6	**Magnets,** Horseshoe, 10 cm long ea., .27	1.62
1	**Meter Stick,** maple, Metric and English ea., .25	.25
3	**Mortars with Pestles,** porcelain, 80 mm. ea., .47	1.41
6	**Platinum Loops,** in glass handles ea., .31	1.86
1	**Retort,** glass, tubulated, "Pyrex," 125 cc. ea., 1.35	1.35
25 ft.	**Rubber Tubing,** white, 3-16 in. (Multiples of 5 ft.) per ft. .08	2.00
12 shts.	**Sand Paper,** No. 00 per 12	.22
	Splints, wood, 500 in pkg.	*
72	**Test Tubes,** soft, 4x½ in. per 144, 1.62	.81
24	**Test Tubes,** soft, 6x1 in per 144, 4.30	.72
4	**Thermometers,** minus 10° to 110° C ea., .55	2.20
1	**Water Bath,** copper, 6 in., 4 rings	1.80
1 spl.	**Wire,** copper, bare, No. 12, 1 lb	.58
1 spl.	**Wire,** copper, bare, No. 18, 1 lb	.61
1 spl.	**Wire,** copper, bare, No. 30, ¼ lb	.31
2 sq. ft.	**Zinc Sheet,** No. 32 per sq. ft., .27	.54
	TOTAL	$91.80

* This equipment can be made by the instructor.

CHEMICALS

(No extra charge for containers)

1 lb.	**Acid Acetic,** C. P. glacial, 99.5%	.60
1 lb.	**Acid Acetic,** 36%, tech	.33
¼ lb.	**Acid Formic,** C. P. liquid, 90 %	.57
6 lbs.	**Acid Hydrochloric,** C. P.	1.38
6 lbs.	**Acid Hydrochloric,** tech	1.08
1 lb.	**Acid Nitric,** C. P.	.55
¼ lb.	**Acid Pyrogalic,** U. S. P. cryst	.73
9 lbs.	**Acid Sulphuric,** C. P.	1.80
9 lbs.	**Acid Sulphuric,** tech	1.44
1 oz.	**Albumen,** egg scales	.25
1 pt.	**Alcohol,** Ethyl, denatured	.25
1 pt.	**Alcohol,** Methyl, absolute	.33
1 pt.	**Alcohol,** Amyl, tech	.55
1 oz.	**Alizarine Paste,** 20%	.20
¼ lb.	**Aluminum Metal,** powd	.30
¼ lb.	**Aluminum Chloride,** C. P. cryst	.49
1 lb.	**Aluminum Potassium Sulphate,** cryst	.18
1 lb.	**Aluminum Sulphate,** tech., gran	.20
1 lb.	**Ammonium Carbonate,** C. P., cubes	.75
¼ lb.	**Ammonium Chloride,** C. P. gran	.39
4 lbs.	**Ammonium Hydroxide,** C. P.	1.32
4 lbs.	**Ammonium Hydroxide,** tech	.72
¼ lb.	**Ammonium Molybdate,** C. P. HNO_3, sol	.55
1 lb.	**Ammonium Sulphide,** Sol., C. P., light	.51
¼ lb.	**Antimony Metal,** powd	.25
¼ lb.	**Barium Chloride,** C. P. cryst	.42
1 oz.	**Bromine,** C. P.	.53
1 oz.	**Cadmium Nitrate,** C. P., cryst	.39
5 lb.	**Calcium Carbonate,** marble chips	.40
1 lb.	**Calcium Chloride,** anhyd., gran., 4 mesh, Tech	.44

1 lb.	**Calcium Fluoride,** tech. powd.	.18
¾ lb.	**Calcium Hypochlorite,** bleaching powder (12 oz.)	.20
1 lb.	**Calcium Oxide,** tech., lumps	.18
1 lb.	**Calcium Hydrogen Phosphate,** (mono) tech	.18
1 lb.	**Calcium Sulphate,** Gypsum, lumps	.20
1 lb.	**Carbon Disulphide,** tech. By freight only	.30
1 lb.	**Charcoal,** animal, gran.	.30
1 lb.	**Charcoal,** wood lumps	.20
1 oz.	**Chromium Sulphate** (ic) C. P.	.36
1 oz.	**Cobalt Nitrate,** (ous) C. P., cryst.	.48
1 lb.	**Copper Metal,** foil, No. 36	.65
1 oz.	**Cupric Bromide,** C. P.	.40
¼ lb.	**Cupric Nitrate,** C. P.	.51
¼ lb.	**Cupric Oxide,** tech.	.22
1 lb.	**Cupric Sulphate,** tech., cryst.	.26
1 lb.	**Dextrose,** gran., tech.	.25
1 lb.	**Fehling's Solution "A"**	.40
1 lb.	**Fehling's Solution "B"**	.60
1 lb.	**Graphite,** flakes	.50
1 lb.	**Hydrogen Peroxide,** 3% U. S. P.	.25
1 oz.	**Iodine,** U. S. P., resub.	.39
1 lb.	**Iron Metal,** filings, fine, oil free	.23
1 lb.	**Iron Chloride,** (ic), C. P.	.60
1 lb.	**Iron Oxide,** (ic), C. P.	.77
1 lb.	**Iron Sulphate,** (ous), tech.	.16
2 lbs.	**Iron Sulphide,** (ous), gran.	.66
1 lb.	**Lead Metal,** gran., (Silver free)	.40
1 can	**Lead Metal,** shot (1 lb.)	.27
¼ lb.	**Lead Acetate,** C. P., neutral, cryst.	.40
¼ lb.	**Lead Nitrate,** tech.	.18
1 lb.	**Lead Oxide,** tech. (Litharge)	.26
1 oz.	**Lithium Nitrate,** C. P.	.47
1 oz.	**Litmus, cubes**	.26
1 oz.	**Magnesium Metal,** ribbon	.40
1 oz.	**Magnesium Metal,** powd.	.28
1 lb.	**Magnesium Sulphate,** C. P.	.48
1 lb.	**Manganese Dioxide,** tech., powd.	.22
¼ lb.	**Mercury Metal,** virgin grade	1.50
1 oz.	**Mercury Nitrate,** (ic), C. P., cryst.	.65
1 oz.	**Mercury Nitrate,** (ous), C. P.	.68
1 oz.	**Mercury Oxide** (ic), red powd., N. F.	.38
1 oz.	**Methyl Orange,** dry	.40
1 pt.	**Oil,** cottonseed	.40
1 oz.	**Phenolphthalein,** U. S. P., powd.	.24
1 oz.	**Phosphorus,** red, amorphous	.21
¼ lb.	**Potassium Bichromate,** tech., cryst.	.18
¼ lb.	**Potassium Bitartrate,** U. S. P., powd.	.30
¼ lb.	**Potassium Bromide,** U. S. P.	.18
1 lb.	**Potassium Chlorate,** cryst., tech.	.57
¼ lb.	**Potassium Ferricyanide,** C. P.	.77
¼ lb.	**Potassium Ferrocyanide,** tech.	.20
¼ lb.	**Potassium Hydroxide,** U. S. P., sticks	.26
1 oz.	**Potassium Metal,** balls	1.25
1 oz.	**Potassium Iodide,** U. S. P., cryst.	.22
1 lb.	**Potassium Nitrate,** tech.	.30
¼ lb.	**Potassium Permanganate,** U. S. P.	.18
¼ lb.	**Potassium Sulphate,** C. P. coarse cryst.	.42
¼ lb.	**Potassium Thiocyanate,** cryst., C. P.	.82
1 oz.	**Silver Nitrate,** C. P.	.83
¼ lb.	**Soap,** castile, powd.	.35
¼ lb.	**Sodium Metal**	.35
¼ lb.	**Sodium Acetate,** C. P., cryst.	.44
1 lb.	**Sodium Bicarbonate,** U. S. P., powd.	.14
1 lb.	**Sodium Bisulphate,** tech.	.25

1 lb.	**Sodium Borate,** tech., cryst.	.22
1 lb.	**Sodium Carbonate,** cryst., C. P.	.53
1 lb.	**Sodium Chloride,** white, fine	.18
1 lb.	**Sodium Hydroxide,** U. S. P., sticks	.56
1 lb.	**Sodium Thiosulphate,** (Hypo), cryst.	.17
¼ lb.	**Sodium Nitrate,** C. P., cryst.	.43
¼ lb.	**Sodium Nitrite,** C. P., cryst.	.49
1 lb.	**Sodium Phosphate,** (mono), C. P.	.88
¼ lb.	**Sodium Phosphate,** (di), C. P.	.39
1 lb.	**Sodium Sulphate,** tech., cryst.	.20
¼ lb.	**Steel Wool,** No. 3	.15
¼ lb.	**Strontium Nitrate,** C. P., cryst.	.64
1 lb.	**Sulphur,** flowers, (sublimed)	.20
1 lb.	**Sulphur,** roll	.20
¼ lb.	**Tin Metal,** (mossy)	.46
1 lb.	**Zinc Metal,** tech., mossy	.35
¼ lb.	**Zinc Nitrate,** C. P., cryst.	.51
1 lb.	**Zinc Sulphate,** cryst., tech.	.25
	TOTAL	$50.23

Why Teach Photography?

HOWARD J. IVENS*

PHOTOGRAPHY is daily becoming an increasingly interesting and popular pastime. At present, it ranks among the leading hobbies from the standpoint of participants and volume of business. It is a hobby that possesses thrilling moments and fascination without depending upon an individual's expertness. His enjoyment begins with the purchase of his first simple box camera. As knowledge and interest increase, his desire for better and more exacting equipment increases. Yet, a lifetime pursuit of photography will fail to limit its possibilities and useful applications. This is true because photography as a hobby is a year-round sport; it is not limited to any age group or season of the year. Contrary to the opinion of a person who has not tried picture-taking, it is not a trick or form of magic, but an art that can be readily mastered by a brief study of the fundamentals of picture-taking.

As evidence of photography's growth as a hobby, a hurried survey of the photographic shops of any community would give conclusive evidence of its importance to that community. From a business standpoint as well as from the number of people involved in photographic interests, the local figures would be quite surprising. In the communities of Bloomington-Normal, Illinois, representing a city of 40,000 population, there are five commercial photographic stores selling photographic supplies and equipment. It is estimated that they handle approximately four thousand roll films of all kinds each week. This figure includes small surrounding towns that do not have photographic shops. The local

* Assistant Professor of the Teaching of Science.

camera club boasts a membership of about 125 active amateur photographers. This figure does not include many of the grade school, high school, or university students who depend upon their schools' extra-curricular programs to serve their needs.

When the public's desire for anything grows as rapidly as this interest has, then it is time for the schools to assume some responsibility and to have some desire to give service in the field. A program of special help and instruction in photography should be introduced in the schools today to care for this ever-increasing interest shown by students so that they will be more capable of good picture-taking after they leave school. Such a program of systematic instruction as would serve the students' needs rightfully comes within the scope of the science departments. In science teaching, one objective has always been to help the individual to live his life better. Such training in photography contributes to this objective and also makes a contribution to society as a whole. If one recognizes that education is more than classroom instruction, that it is a combination of many experiences that take place while people work, play, talk, visit, attend movies, and read from modern newspapers and magazines, then he should become more conscious of the place photography occupies in these educative experiences.

Still, photography as a hobby is but one of many reasons why teachers should assume the responsibility for giving the necessary instruction in the schools. A second reason is to help interested individuals take and make better pictures in order to cut down on some of their wasted time and film. A large percentage of the film consumed today does not result in desirable pictures. This, however, is no fault of the cameras used or film purchased because both are much superior today to any of those of the past. The main cause of this difficulty is a lack of understanding of the principles of light and lenses by those taking the pictures. Too much of the amateur's success depends upon being lucky in just happening to set the lens opening and shutter speed correctly. Teaching photography as a part of the science program would prevent a great many overexposed, underexposed, and blurred pictures that will result from the great quantity of film that will be consumed by the American public in the years following their school experiences.

A third reason for teaching photography is that it is closely related to the present National Defense Program. The science programs of the public high schools, colleges, and universities will be asked to take an increasingly more active part in the individual's preparation for national defense needs. Instruction in photography is one of these needs to which teachers can readily contribute. All of the reconnaissance flights of the present European war have been dependent upon photography for their records. In this field, Germany leads the world.

Shortly after the beginning of the present war, Germany released to *Life Magazine,* pictures of London that were of extreme detail and accuracy. They were so accurate that they were

about as valuable as a trained observer on location. At present, most bombing planes carry photographic equipment to record the accuracy of their bomb placements. Then, too, camouflage has always been an important part of both military offense and defense. Fooling the human eye has been a comparatively easy task, but fooling the modern camera with infra-red film is not so easy. Almost any attempt at camouflage can be detected by means of photography. In peace time this same aerial photography can be used for map making, aerial surveys, large scale crop surveys, crop and land appraisals, and for permanent records.

The nature and extent of the preceding uses show that now and in the future it will be necessary to prepare more people in the art and understanding of photography. Here is a whole new field of endeavor which students of today hardly recognize. Certainly, early basic training in photography would encourage more people to look toward this work as a life profession, as well as direct people into some of the many allied industries which accompany it. At the present time, only a few universities and very few high schools are attempting to give photographic training. The present need indicates that the time has passed when it should have been made a part of the science curriculum.

A fourth reason for studying photography would be for its value in teaching the student the importance of research to industry. Large manufacturers of photographic supplies have always been among the leaders in chemical research. The first world war taught the difficulties of being dependent upon other nations for so many basic chemical supplies. At that time the United States government was dependent upon Germany for a great many dyes and chemicals. Today this nation is independent in both, largely because of the reasearch of the large photographic manufacturers in their search for new methods and new materials. A better understanding of photography will help to teach the importance of the chemical industry, as well as the importance of scientific methods of research and problem solving, both of which are so important to science teaching.

Perhaps the most important use for photography from a teacher's standpoint is its relationship to the materials and methods of visual education. Every teacher readily recognizes the value of the many available visual aids to classroom teaching. As a result, photography is becoming more and more essential to the learning process. Also, it is rapidly increasing as a means of communication between people. Words alone do not and can not convey the full meaning of events and places. Teachers are realizing that words alone can often fail to interpret for students and often promote misunderstandings. Through the use of the camera, teachers can now provide themselves with any amount of visual material as concrete evidence of the experiences they wish to give to their students. This is true of not only classroom experiences but outside experiences as well. People of today are continually increasing their use of the

moving picture, the news reel, picture magazine, illustrated newspaper, and picture advertisement in their daily lives. In all these ways people are depending more and more upon the visual evidence of the camera for their interpretations. To insure good use of these aids, teachers and laymen should have a better knowledge of the fundamental principles and processes involved in picture-taking and picture-making. Through such an understanding, teachers can better make use of photographic documents and pictures to create interest and hold the attention of their students.

A further example of the increasing importance of photography in learning is the great change in type and quantity of illustrative material in present day textbooks. Many authors are actually providing their own illustrations photographically rather than depending on the chance of finding suitable materials from other sources. S. B. Zisman, assistant professor of architecture, Agricultural and Mechanical College of Texas, writing in *Graphic Graflex Photography* states that he believes that before long book publishers will actually assign commercial photographers to illustrate a text, much as newspapers now assign reporters and camera men to cover a news story. This is just one more way in which photography will demand more specially trained people to meet the needs placed upon it.

Still another use for photography is aiding classroom teaching in making projection slides. Many teachers have already learned the value of using the camera for producing teaching aids as well as for pleasure. The making of slides can readily be done by classroom teachers without an elaborate photographic darkroom and expensive equipment. The popularity of the 35 mm. camera and the use of color film have greatly increased the value of slide projection. With very reasonable equipment a teacher can now plan and take color pictures that meet the particular needs of his classroom work. Such pictures readily make an excellent record of special trips and events for later school use.

Many schools are beginning to make more use of the small movie camera to record events of special interest to their faculties and students. Sports departments have found great value in using the movies to show where more emphasis should be placed in the coaching of their teams. After the season closes, these same pictures serve as excellent material for group programs and alumni activities. The movie camera can also serve as an excellent way to make permanent records of special events taking place about the school, such as pageants, open house, musical contests, or field days. Such pictures could serve as an excellent medium for generating interest in future activities and for a permanent record from which improvements of future activities could be worked out. On special field trips, which can not often be duplicated, excellent records in the form of pictures can be easily made so that future classes can profit by the experience of previous classes.

The use of the camera is very valuable in recording the activities of individual classes and their special

accomplishments. It can serve excellently in interpreting the schools to the public, but especially can it be valuable within the school itself. Particularly in a large school system it can be used to acquaint all teachers with the outstanding work being done by certain teachers and certain classes. It could be an excellent medium for instilling new ideas and new philosophies in keeping with more modern educative procedures.

Many schools could improve greatly upon their yearbooks by the introduction of photography for their students. The students themselves would have greater interest in actually portraying the life of their school in pictures. Individual pictures and sport pictures especially could be easily cared for by individual student photographers or photographic club groups. If adequate camera equipment is available, even the large group pictures can be made by student and teacher activity.

It would be quite difficult to discuss all the ways in which photography either directly or indirectly aids in teaching. It can be a big help to the teacher in presenting his work, a help to the student in understanding his work, a practical value to the school, and a help to students after leaving school. In each of these four main ways that photography can be of service to the schools, many individual applications can be listed. In order to summarize why photography should be taught by the schools, the following reasons are listed:

1. To help provide illustrative material for the classroom.

2. To help train students and teachers to interpret better the visual aids they come in contact with in their every day lives.

3. To assist teachers in increasing the interest and holding the attention of students in their work.

4. To understand better the relationship of photography to the illustrative material used in modern textbooks.

5. To teach methods and to provide means for making projection slides for classroom use.

6. To teach and to understand how the small movie camera can be used for permanent records of sports and all school events, as a valuable entertainment device, and for public relations program.

7. To make permanent records of individual classroom activities and accomplishments.

8. To help provide the yearbook record of the school's events or to help improve the present yearbook.

9. To help provide an artistic medium for self-expression. In this respect it would serve a purpose similar to art, painting, and sculpture. It could readily be used as an aid to the regular art course of the school.

10. To point the way for young people to an entirely new field of industry, of which they have probably heard very little.

11. To be an important aid to the constantly expanding National Defense Program.

12. To give some specialized training in a scientific field in which so large a group of people are today dependent for their leisure time activity and their self expression.

Functional Physical Science

L. S. SMITH*

AS THE American defense program goes into high gear, the great need for skilled workers and technically trained people becomes obvious. In every urban community, trade schools and night schools are increasing. These schools are featuring such skills as those that depend upon the physical sciences. The courses are concerned with gasoline and Diesel engines, electric power and power transmission, and aviation for civilian pilots as well as other problems of a similar character.

Several questions naturally arise. Why is there such an intensive interest in the technical fields? Have the educational institutions been neglecting these fields? Even if there has been negligence, should the blame be placed on the secondary schools, or the universities and colleges? How may such negligence be corrected? Have the research scientists here kept pace with those of other countries? These and many other leading questions may be raised.

If one is to judge by the demand for technical and semi-technical workers, it appears that the secondary school and the university are both at fault for not having sufficient numbers from which to draw; yet, the high schools must take the greater part of the blame. Statistics available prove that the percentage of high school students taking physical science courses has been decreasing during the last decade. If the high schools had the facilities for teaching a type of science more helpful to industrial workers in getting and holding jobs, then the defense problem would be a much simpler problem than it is today.

Whenever production requiring technical skills is to be doubled or tripled, new problems involving research arise. Thus, the demand for additional technical workers and research workers is necessary. Though technical schools have not been idle, an increased demand has overtaxed their capacity. American industry has continued to grow during the depression years in spite of stifling restrictions for various reasons.

It may be well to list a few of the advances in science and industry during the depression years. Passenger air traffic has been promoted across the Atlantic and Pacific. New methods of oil refining and processing that will call for millions of dollars of plant expenditures have been developed. Synthetic rubber and new plastics have been created. Synthetic vitamins and hormones have been produced. Air conditioning, colored motion pictures, better safety glass and glass products, and neon lighting have been developed. Television, streamlining, Diesel engines, new steels and aluminums, and new drugs to combat disease have been improved.

* Assistant Professor of Physics.

Though glass has been used for a great many years, during recent years it has been developed in new forms with new properties. Tough glass which retards the flow of heat is used for building bricks and handles for cooking utensils. Resistant glass through which electricity can scarcely pass is used for vacuum tubes and electric insulators. Glass is used for frying pans, fireproof cloth, and even for spring boards for swimming pools. Glass can be so constructed that it will stop machine gun bullets. Glass building bricks will lose heat to the cold outside air only about half as fast as ordinary bricks and hence will serve as heat insulators. With such valuable properties in so many important fields, is it any wonder that over three million tons of glass products are used in this country annually?

When the electric light was developed, the glass blower made the bulbs. The art of blowing glass progressed to the place where a single blower and his helper could produce one thousand bulbs a day. This, however, was too slow and machines were produced that could turn out as many as fourteen completed bulbs each second. Today, machines blow most of the lamp and radio bulbs whereas individual blowing is done for odd lots which are needed in too small quantities to be worth making with machines. If ordinary glass is heated suddenly, it breaks into pieces because of unequal expansion. When hot glass is allowed to cool, breaking or cracking is caused by unequal contraction. The scientists of the Corning Glass Works attacked the problem of developing a glass which would change its volume less than one-ninth as much as ordinary glass does when its temperature is changed. They found that by using the right amount of borax they could produce a glass which expanded less and was more resistant than other glass to weather, heat, and electricity. They gave it the trade name Pyrex. The new Pyrex will not break, even when heated on top of a stove.

During the experimental work on Pyrex, glass physicists discovered that baking is done mostly by waves of radiant energy which travel around the oven, and not by conduction between the hot air and the hot metal. They found that the new glass utensils reflected the radiant energy less than metal would and therefore would bake more efficiently. When these glass dishes are removed from the oven, the food cools more slowly than it does in metal dishes.

Since the average individual spends about eighty per cent of his time indoors, it is important that ample thought be given to the problem of ventilation. Air for breathing should be clean, should be at the proper temperature, should contain humidity of the correct amount, and should be slowly moving. These conditions of the air may be produced by the following operations: it must be heated or cooled, moistened or dried, cleaned, and circulated.

The problems of temperature and humidity are extremely important. Conditions outdoors are very closely related to indoor conditions. Experiments have shown that, in winter, children kept in school rooms heated

to 68 degrees Fahrenheit, have fewer colds than those kept in rooms either hotter or colder. Indoor summer temperatures must be kept relatively high to avoid sudden chilling on entering the house. When the outdoor air is as high as 95 degrees Fahrenheit, the indoor air should not be cooler than 80 degrees. The relative humidity should be so adjusted that its value lies between thirty and seventy per cent. Air can be either dried or moistened by spraying water into it. A cold spray into warm moist air removes vapor, whereas a warm spray will add moisture to the air.

It has always been easier to warm a room in winter than to cool it in summer. Today, cooling costs two or three times as much as heating. The melting of two thousand pounds of ice will absorb only as much heat as can be generated by burning twenty pounds of coal. The ice would cost at least four dollars whereas the coal would cost but a few cents. Since the development of electric refrigeration, the cooling process can be carried on at about a third the cost of melting ice. Authorities estimate that cooling a small house in this latitude might cost $240 a season. This is nearly four times the cost of heating it.

Energy is required to heat a home and also to cool a home. Both the furnace and the refrigerator require fuel or power. The furnace builds a "thermal hill," whose temperature is higher than its surroundings, whereas the refrigerator digs a "thermal hole," whose temperature is below that of its surroundings. Present day heating systems are much more efficient than older forms and yet there is enough fuel wasted in the heating plant to run several refrigerators. The heat rejected by the refrigerator is usually wasted and if put to use might be used for heating purposes.

The ultimate goal in home construction will be brought about by better insulation, in which there is a better balance of energy losses between winter and summer. Insulated homes will last longer since they are not subject to violent internal strains which are produced by expansion and contraction, because of temperature changes.

In teaching the physical sciences, one should not forget the functional aspect. However, there is a vast amount of material necessary to produce the background needed for the best functional use. In the larger high schools, segregation of pupils into groups that have a common interest will allow the teacher to present such material as will enable the students to become successful homemakers, or will increase their earning power. Teachers working in the secondary schools must have a wealth of background material if they are to teach by the application of physical principles to specific problems. From present day experience in defense industries it would seem that it is time for an acceleration in the teaching of physical sciences in the educational system.

Forthcoming Campus Events

April 4. Division of Rural Education will hold its annual Director-Teacher Meeting in Capen Auditorium at 7:30 P.M. There will be demonstrations by pupils from the rural affiliated schools of work in art, music, and physical education.

April 5. The Subdistrict High School Speech Contest under the auspices of the Speech Department.

Annual Vidette Banquet at Tilden-Hall. 6:30 P. M.

Annual Spring Banquet of Kappa Mu Epsilon Mathematics Fraternity.

The Senior Round-up of Home Economics graduates. 9:30 A. M.—2:00 P. M.

April 6. Annual Banquet of Gamma Delta, the organization of Lutheran students.

The Bloomington-Normal Philharmonic Society will present the Oratorio "Elijah" in McCormick gymnasium at 8:00 P. M.

April 10-21 inclusive. Spring vacation tion.

April 25. The Entertainment Board presents the lecturer, Dr. Gerald Wendt in Capen Auditorium at 8:15 P. M.

April 28. College Day for High School Students.

April 29. Open House. Opportunity for the general public to visit the university including National Defense Training Classes.

May 2. The University Club will present its Stunt Show in Capen Auditorium at 8:15 P. M.

May 3. Kappa Delta Epsilon, honorary educational sorority will hold its Founder's Day Dinner at 6:30 P.M.

May 4. The Annual Mother's Day Service will be held in Capen Auditorium at 4:00 P. M.

At 6:00 P. M. the Newman Club, the organization of Catholic students, will hold its annual spring supper at Roland's Tea Room.

May 9. The McLean County Music Festival will be held in Capen Auditorium in the evening.

May 17. The Negro students of the University will hold their annual party in the Women's gymnasium at 9:00 P.M.

May 18. A festival sponsored by the Music Department and the Lowell Mason Club will be held in Capen Auditorium.

May 23-24. The Dramatic Department will present the Commencement Play in Capen Auditorium at 8:15 P. M.

May 30. Memorial Day. University closed.

June 6. Last day of the second semester.

June 8. Baccalaureate Service.

June 9. Annual Commencement program preceded by Alumni Reunion and Luncheon.

Professional Activities of the Faculty

DR. S. S. MARZOLF, assistant professor of pychology, has given an address called "Prejudice," at several meetings recently, including the Towanda PTA, and the Bloomington Junior Women's Club.

MISS BERNICE TUCKER, assistant professor of the teaching of home economics, delivered an address on "Home Economics in the Defense Program" at the District Meeting of the Illinois Vocational Homemaking Teachers Association, March 1, at Macomb, and on March 5 at the joint meeting of the Business and Professional Women's Club and Delta Kappa Gamma, Bloomington. She also reported on the "Home Economics Curriculum Development in Illinois" at the homemaking teachers meeting at the Illinois Vocational Association on March 28.

DR. MARGARET COOPER, director of the Division of Elementary Education, recently spoke for the League of Women voters over the radio at Bloomington on the subject, "What Should the Elementary School Offer Your Child?"

EUGENE HILL, instructor in physical education, delivered a speech on the topic, "Physical Fitness," March 20, at the basketball banquet at Heyworth. He officiated at the state high school wrestling meet for the second time in the same number of years.

DR. NINA E. GRAY, assistant professor of biology, is continuing as national secretary of Sigma Delta Epsilon for 1941-1942, having been re-elected to this office in December at the National Convention in Philadelphia, Pa.

DR. JOHN W. CARRINGTON, director of the training schools, was the mid-year commencement speaker at Feitshans High School, Springfield, on January 23. The subject was "Opportunities for Youth in a Changing World." "Laboratory Schools Without Student Teaching" was the subject of an address presented by Dr. Carrington at the Atlantic City meeting of the National Association of Supervisors of Student Teaching, on February 24.

DR. R. W. FAIRCHILD, president of the university, has given several radio addresses on educational topics in the past few weeks. He has spoken over WMBD, Peoria; WJJD, Chicago; WILL, Urbana; and WJBC, Bloomington-Normal. At a meeting of the American Association of Teachers Colleges, held at Atlantic City on February 22, Dr. Fairchild presented a report of the committee on organization and administration of teachers college libraries, of which he is chairman.

LAVERN A. LAUBAUGH, assistant professor of agriculture, addressed the Heyworth Community Club on February 24 on the subject, "Home Grown and Commercial Feeds."

ELINOR B. FLAGG, assistant professor of mathematics, addressed the McLean County intermediate teachers at Bloomington on February 15, on the subject, "Diagnostic and Remedial Arithmetic."

MISS MARY D. WEBB, assistant professor of the teaching of commerce, helped to organize the Normal Area Business Education Club, a division of the state commercial teacher's association. She is secretary-treasurer of the group.

DR. LUCY L. TASHER, assistant professor of history, spoke on the subject, "Our Relations with the Warring Powers" at the Tremont Women's Club, on February 21.

Presenting an analysis of high school districts in relation to the population of Pike County, DR. JOHN A. KINNEMAN, associate professor of sociology, is co-author with RUSSEL S. SHELTON of an article in *School Review* for February, 1941, entitled, "High-School Communities in an area of Declining Population."

LESLIE M. ISTED, assistant professor of music, was judge of the vocal and piano contest at Roanoke on March 13 and of the solo and ensemble contest of the central Illinois district held at Chenoa on March 15.

DALE B. VETTER, assistant professor of English, addressed the student teachers of reading and English at the Northern Illinois State Teachers College at DeKalb, on February 21, on the subject, "Remedial Reading: Reflections on Johnny."

DR. RICHARD G. BROWNE, associate professor of social science, spoke on current events at the city PTA meeting at Taylorville, on February 20. Each Monday evening, Dr. Browne is teaching in the Community School for Adults under the auspices of the Lincoln Library of Springfield.

DR. HELEN E. MARSHALL, assistant professor of social science, discussed "Pioneer Women Teachers in Illinois" at a dinner meeting of the Delta Kappa Gamma society held at Pana on March 15.

HARLAN W. PEITHMAN, assistant professor of music, presented moving pictures of points of musical and historical interest at the Optimist Club of Bloomington on March 12. Mr. Peithman took these pictures himself while a student in Germany a few years ago.

MISS KATHERINE E. CARVER, assistant professor of Latin, addressed the state Latin conference at Galesburg on March 8. She spoke on the subject, "Straightening Out the Latin Sentence."

DR. C. F. MALMBERG, associate professor of psychology, addressed the national convention of the Council of Personnel and Guidance Associations, which met at Atlantic City on February 21. The subject of Dr. Malmberg's talk was "The Significance of Personnel Work in World War I." President of the Teacher's College Personnel Association for the fourth consecutive year, Dr. Malmberg was elected a member of the board of directors of the National Association of Teachers of Educational Measurements. With DR. CLIFFORD N. MILLS, professor of mathematics, Dr. Malmberg prepared and published the tenth annual report on the cooperative personnel program

of the Teacher's College Personnel Association. This publication presents a summary and conclusions from ten years of cooperative personnel work.

C. A. HARPER, associate professor of history, addressed the Peoria division of the Illinois Education Association on March 14, on the topic, "The International Situation." On January 15, "America and the War" was the topic Mr. Harper discussed at the Delavan Women's Club, and on January 18, he spoke on "International Affairs" at a meeting of social service groups in Decatur.

MISS MABEL CROMPTON, assistant professor of geography, was the speaker at the Fairbury Women's Club on January 9. Her topic was "Land of the Midnight Sun." The Men's Club of Hudson was Miss Crompton's audience on February 21 when she gave her "Impressions of Northwest Europe." Miss Crompton's talks have been illustrated with Kodachrome slides which she herself took in Europe during the Summer of 1939. The December issue of *Transactions of the Illinois State Academy of Science* contains an article written by Miss Crompton on the subject "Brittany and Cornwall—Geographical Twins."

CLARENCE ORR, associate professor of social science, was speaker at the father and son banquet at Farmer City, on November 8. The subject was "Young People in Citizens' Duties." He gave the same talk at the Mackinaw Father and Son's meeting on March 28.

MISS MARY E. BUELL, assistant professor of home economics, addressed the Jefferson School PTA in Bloomington on March 11. She chose as her subject "Relative Values in Homemaking."

DR. CHARLES E. DECKER, director of the division of secondary education, was the Rotary Club speaker at Pontiac on February 18.

DR. MARIE FINGER, supervising teacher in the seventh grade, spoke at the Founder's Day meeting at the PTA at Stanford on February 20. "Choices" was the subject of her talk.

MISS ESTHER MARIE HUMPHREY, instructor of social studies at University High School, is the author of a radio play entitled "The American Way," which is published in the March issue of *The Social Studies*. This play was originally presented for a radio broadcast by an American Citizenship class composed of high school juniors and seniors under Miss Humphrey's direction.

MISS FRANCES CONKEY, acting head of the home economics department, spoke on "Vocational Guidance in Home Economics" at the home economics section of the Peoria division of the Illinois Education Association on March 14.

DR. DEWEY FRISTOE, supervisor of student teaching in the Houghton school, is the author of an article entitled "Good Teachers Most Important," which is published in the December issue of the *Illinois Agricultural Association Record*.

FLOYD T. GOODIER, director of integration, has recently spoken before several central Illinois audiences on the subject, "Desirable School Legislation for Illinois."